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Abstract

EIGENFUNCTION EXPANSION METHOD IN NEUTRON TRANSPORT THEORY

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The paper is devoted to the general solution of the Boltzmann equation of neutron transport theory by means of the eigenfunction expansion method, which opens new and wide perspectives in this field.

The method is described on the basis of the one-velocity Boltzmann equation with isotropic scattering of neutrons for arbitrary geometry.

The fundamental notion of the eigenfunction and the eigenvalue of this equation is introduced and their properties are discussed. Then the general solution of the Boltzmann equation is constructed and the boundary value problem formulated.

Some examples of problems with different symmetry properties are given. Other efforts in this direction based on different ways of attack are reviewed critically and commented. This relates specially to spherically symmetric problems.

This approach is extended later taking into account the anisotropic scattering of neutrons, energy dependent kernels and time-dependent problems in plane geometry. The eigenvalues and corresponding eigenfunctions for these cases are discussed and the appropriate completeness theorems are sketched. The possible applications of this approach to critical and spectral problems in reactor theory are formulated and examined.

In the Appendix the most important information concerning the theory of singular integral equations and basic mathematical concepts relevant from the point of view of their application in neutron transport theory is given and discussed.

Special attention is paid to the problem of reduction of the singular integral equations to the Fredholm ones, and to the additional conditions which must be satisfied by their solutions. These conditions are connected intimately with the indices of singular integral equations and play the most important, physical role in the theory.